Defense Technology Strategy

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About the Report

This report is produced as part of the U.S. National Technology Strategy project at CNAS. The project develops the intellectual framework for a national technology strategy for the United States that can serve as a roadmap for successful long-term American innovation and technological leadership. The project focuses on how the government should establish technology policy on key issues such as accelerating American innovation, mitigating risk to U.S. advantages, and contending with the technology strategies of competitors.

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Introduction

Technology always has been an integral part of achieving military superiority. A stone axe or wooden club gave a Neolithic fighter a major advantage over an unarmed opponent. As weapons have evolved from bows and arrows to intercontinental ballistic missiles, militaries continuously have sought to harness new technologies to gain an edge on adversaries. Technology alone rarely conveys a decisive advantage, but technology is an enabler for military superiority. When combined with the right organization, training, and concepts for warfighting, technological advantages can make battles hopelessly one-sided affairs. By harnessing advances in stealth, GPS, and precision-guided weapons, the United States dismantled Saddam Hussein's army during the Persian Gulf War with a 30-to-1 casualty ratio.[1] Yet other countries took notice and have been investing in capabilities that have eroded America's military technological edge.

The United States had a first-mover advantage in the information revolution, but the technology that enabled American military dominance in 1991 now has proliferated. Adversaries have invested in long-range ballistic and cruise missiles that can target American bases and carriers with precision, integrated air defenses to hold stealth aircraft at bay, counter-space weapons to blind military spy satellites and disrupt command-and-control, and cyber weapons to cripple logistics. This suite of capabilities, sometimes lumped under the label "anti-access/area denial," is meant to hamper America's ability to project power overseas, buying time for adversaries to change conditions on the ground through force. The United States must transform its way of warfighting to project combat power in the face of these capabilities so the United States can deter and, if necessary, defeat military aggression by potential adversaries.

Senior Defense Department leaders have looked to new technologies, from artificial intelligence (AI) to hypersonic missiles, to reinvigorate the U.S. military's technological edge vis-à-vis great power competitors. To do so, the United States will need to adopt a technology strategy appropriate for today's technology landscape. The approach the United States used in the 1960s, '70s, and '80s won't work today, when innovation is increasingly globalized and driven by the private sector. Nor does the U.S. military have sufficient resources to invest in every conceivable technology, even with a $700 billion-plus defense budget. The Department of Defense (DoD) will have to make strategic bets in the technologies most likely to rapidly transform warfare, while hedging against surprise with smaller bets elsewhere.

U.S. defense leaders have sent conflicting signals about their technology priorities. In 2014, then-Secretary of Defense Chuck Hagel launched the Defense Innovation Initiative to develop a "game-changing third 'offset' strategy."[2] Then-Deputy Secretary of Defense Robert Work subsequently named AI and autonomy the "technological sauce" to empower this Third Offset Strategy.[3] But defense leaders since then have offered shifting and at times conflicting guidance on new technology priorities. Recent Undersecretary of Defense for Research and Engineering (USD(R&E)) Michael Griffin publicly listed his top "priority technology domains" but amended the list approximately four times between its initial release in April 2018 and his departure in July 2020. These priorities fluctuated in number and order; they ranged from 10 to 13 priorities with AI, hypersonics, nuclear modernization, and other technologies rotating up and down in importance. Secretary of Defense Mark Esper remarked at his confirmation hearing that "Different people put different things at number one; [for] me, it is artificial intelligence."[4] Yet the Fiscal Year 2021 Defense Wide Review issued under then-Secretary Esper's leadership characterized nuclear modernization as "the highest modernization priority."[5] A few months later in April 2020, Director of Defense Research and Engineering for Modernization Mark Lewis stated in an interview, "my number one technology priority is actually microelectronics."[6] With Griffin's departure, the new Acting USD(R&E) Michael Kratsios identified "microelectronics, 5G, hypersonics, and AI" as technology priorities at his first public event, along with "quantum computing . . . and other industries of the future."[7] In total, five different defense leaders have articulated an ever-shifting array of technology priorities over the last several years with AI, hypersonics, nuclear modernization, and microelectronics all occupying the top spot as the "number one" priority at different times.

DoD leaders' attempts to publicly communicate their technology priorities are commendable, but the manner in which they recently have done so has been chaotic, confusing, and counterproductive. The DoD needs a coherent technology strategy to equip itself for long-term technology competition. The current approach, in which DoD priorities whipsaw based on the whims of senior leaders, jeopardizes budgetary stability and likely consumes undue time and effort within the department. Esper's observation that "different people put different things at number one" is precisely the problem.[8] Senior leaders are entitled to their views, but a technology strategy that changes every time there is a turnover in leadership creates uncertainty and undermines the department's ability to make long-term investments.

Rather than a personality-driven approach, the DoD needs a transparent framework for identifying technology priorities that will provide clarity and stability in the department's priorities. If DoD leaders offer a transparent rationale for which technologies matter, they are more likely to gain necessary support from legislators, the rest of the department, and private industry to achieve technology objectives. Clear priorities are especially critical now, given budgetary competition from the COVID-19 pandemic and the reality that the Pentagon is no longer the primary driver of American technological innovation. The department cannot afford to invest in every technology. To succeed in the long term, it will have to find ways to leverage the evolving innovation landscape and garner the institutional support to do so. The DoD needs a technology strategy to maximize the returns on its technological investments and to signal the rationale behind them. While the current personality-driven approach has spanned multiple administrations, the incoming Biden administration has an opportunity to establish a more strategic process within the DoD for setting technology priorities.

This paper proposes a technology strategy for the DoD based on the current highly globalized, private sector-dominated technology ecosystem. The dominant global technology trend today is the information revolution, which is leading to exponential growth in digital capabilities (networks, data, and computing power). If the U.S. military is to remain competitive in future fights, it must successfully capitalize on this trend and outcompete adversaries in rapidly adapting information technology to warfighting advantage.

The DoD should adopt a three-tiered approach to technology investments:

1. **Digital Technologies Riding Exponential Curves.** The number one focus of the DoD's technology strategy should be to rapidly adopt digital and information technologies, which are often matured in the commercial sector, and harness them for military-specific needs. The DoD should move aggressively to put prototypes in the hands of warfighters, experimenting with new ways of fighting to achieve battlefield advantage. The capabilities most likely to see dramatic change in coming years are those that harness digital exponential trends: cyber, electronic warfare, sensors, data, networks, cloud computing, AI, autonomy, robotics, genomics, and synthetic biology.
2. **Key Military-Specific Technologies.** The DoD also should invest in key military-specific technologies, such as directed energy weapons or hypersonic missiles, when there is clear military operational value in doing so but should expect advancements in these areas to be more incremental. Non-digital technologies such as materials, optics, energy, and power are improving, but not at the same exponential growth rates as information technology, and they are less likely to yield transformative changes in warfare in the coming years.
3. **Paradigm-Shifting "Wild Cards."** Finally, the DoD should invest in paradigm-shifting "wild card" technologies that appear to have a low-likelihood of reaching operationally relevant maturity in the near term, based on current trends, but would have revolutionary effects if achieved. Examples include quantum technologies (quantum computing, communications, and sensing), brain-computer

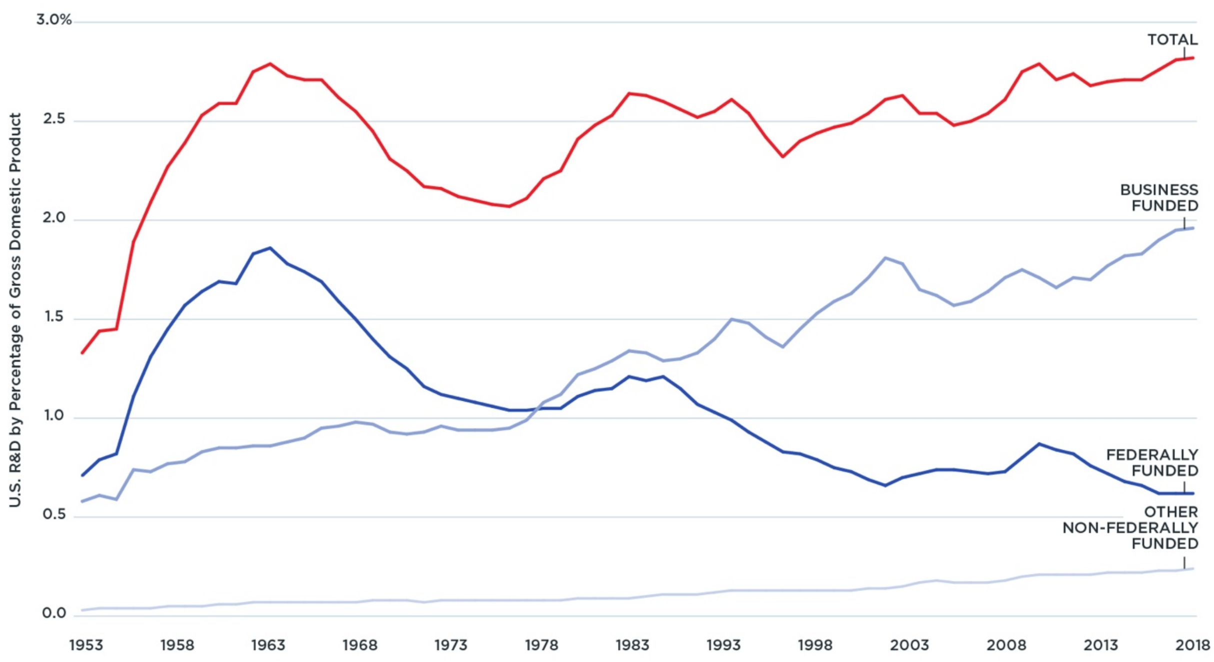
interfaces, artificial general intelligence, and nanotechnology. Investments in these areas would help the DoD hedge against strategic surprise and give early warning of dramatic change in these areas, but the DoD should not bet on the likelihood of these technologies reaching operational maturity in the near term.

This three-tiered investment strategy would help the DoD invest in the most critical technologies for future conflicts, while hedging against surprise elsewhere. The remainder of this paper will more fully explore the current global research and development (R&D) ecosystem, trends in information technology, and the rationale for this strategic approach.

Today's R&D Ecosystem

The U.S. R&D ecosystem has shifted dramatically over the past several decades. The DoD is no longer the dominant player in the U.S. R&D landscape. In the 1960s, the federal government funded two-thirds of U.S. R&D, and the Department of Defense alone funded about half of national R&D. Today, the DoD is responsible for one-tenth of U.S. R&D,[9] and the federal government's overall share has declined to less than one quarter, with the private sector filling in the gap.[10] Total U.S. R&D funding as a percentage of GDP is still roughly the same, but the roles of the federal government and private sector have flipped.

U.S. R&D Funding as a Percentage of Gross Domestic Product, 1953–2018



In the 1960s, the federal government funded two-thirds of U.S. R&D. Today, that has declined to less than one quarter with the private sector filling the gap. The DoD must adapt to a technology landscape where the bulk of technological innovation is outside of the DoD.

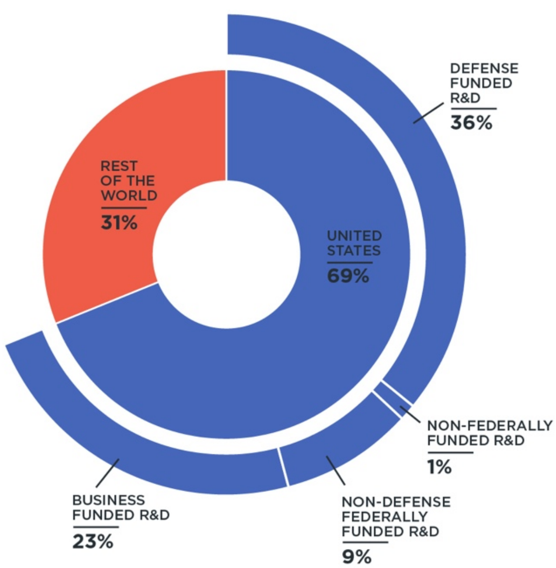
Note: Other non-federally funded R&D includes funds from non-federal government sources, nonprofits, and other entities. Data for 2018 are estimates.[11]

The shift between the U.S. public and private sector in R&D spending means that the bulk of technological innovation is happening outside of the DoD. Rather than the DoD being the dominant driver of technology innovation, as it was in the 1960s and ’70s with innovations like GPS, microprocessors, and the foundations of the internet, the DoD is increasingly a consumer of tech innovation happening outside the defense ecosystem. This presents both a challenge and an opportunity for the DoD. The opportunity is that the DoD can piggyback off of innovation that is happening elsewhere and free ride on others’ R&D funding. The private sector R&D landscape is much more robust than it was 50 years ago. The challenge is that the DoD no longer has the same freedom of action in driving the shape of technological innovation. The DoD can make bets in key technology areas, but the bulk of R&D funding is outside of the DoD’s hands. This means that the most important thing the DoD can do is develop ways of rapidly adapting and spinning in technological innovations that occur outside the DoD. If the DoD fails at this, it won’t matter where the DoD invests internally, because the U.S. military will lock itself out of the most significant technological changes. Rapidly spinning in and militarizing tech innovations that happen in the private sector should be the dominant focus of the DoD’s tech strategy.

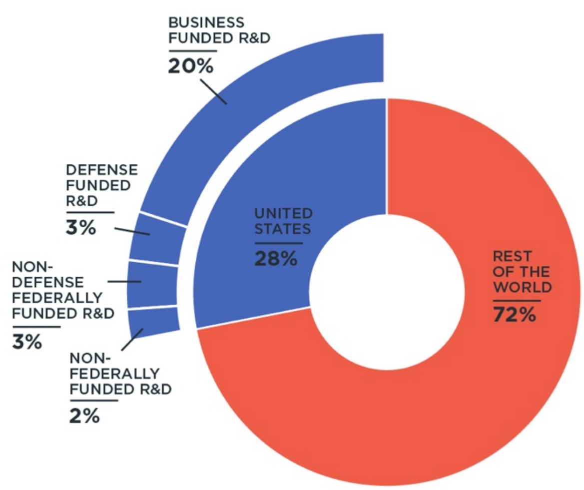
The same shift that happened within the United States has been repeated on a global scale. The United States was once the dominant leader in global R&D, but that is no longer the case. In 1960, U.S. total national R&D spending (public and private) accounted for nearly 70 percent of global R&D; by 2018, that had dropped to 28 percent.[12] The world’s R&D ecosystem has become increasingly globalized. As R&D spending has become more diffuse, the United States remains a large player but is no longer the dominant one.

The combination of these trends means that while the DoD was once a major player shaping the global technology landscape, the DoD occupies a very different position today. In 1960, U.S. defense R&D spending accounted for 36 percent of all *global* R&D; by 2016, it was only 3.7 percent.[13] On the global scale as well, the DoD must adapt to tech trends that are exogenous to the DoD and to the United States.

U.S. Share of Global R&D (1960)



U.S. Share of Global R&D (2018)



The Department of Defense’s ability to drive global technology development has diminished due to its shrinking share of global R&D spending. The DoD must adapt to exogenous tech trends and import tech developed outside the defense sector faster than competitors.[14]

In the global competition for military-technical advantage, the most significant gains will come from those who are able to rapidly import new technologies into their defense enterprises and adapt faster than competitors. Spending more money on defense R&D is valuable, but no amount of expenditures will reverse this trend. The United States is now competing in a truly globalized R&D ecosystem and will need to be able to rapidly adapt to a technology landscape that is largely outside of its control.

The Information Revolution

The most significant trend in the global technology ecosystem is the information revolution. Information technology is seeing exponential growth in a number of dimensions—data, networks, and computing power.

- There are an estimated 22 billion connected devices in use today, growing 10 percent annually to an estimated nearly 30 billion devices by 2023.[15]
- Internet of Things (IoT) devices, which include smart meters, medical devices, home appliances, and industrial applications, are growing at the fastest rate and by 2023 are expected to account for over half of all connected devices.[16]
- These devices create data and share it across a global network that trafficked an estimated 250-plus exabytes of data per month in 2020. Global internet protocol (IP) traffic is growing even faster than connectivity, at a rate of 26 percent per year. Global IP traffic is expected to increase to nearly 400 exabytes per month by 2022.[17]
- Network speeds are increasing to account for this data. Broadband speeds are expected to more than double and wireless speeds more than triple by 2023.[18]

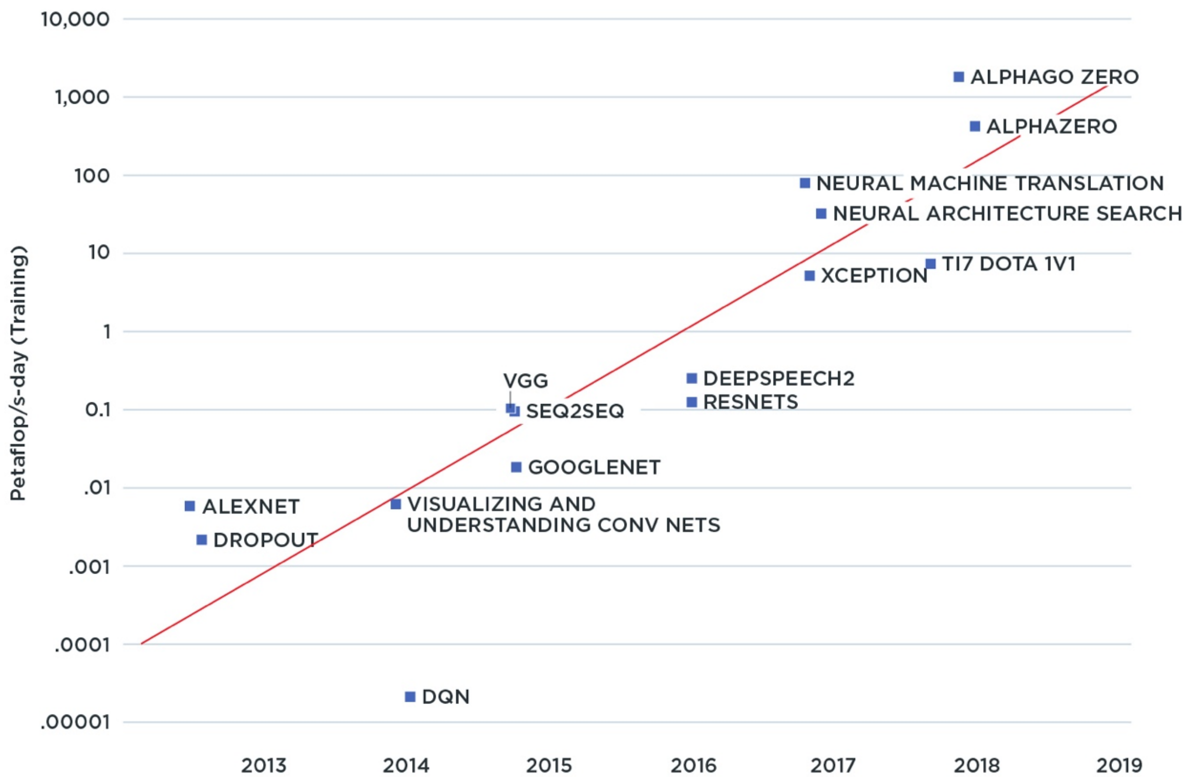
To give a sense of scale, if the amount of data transmitted through global networks today was represented on paper, it would be a stack of paper that would stretch from the earth to the sun and back—every day.

All of these trends are growing at an exponential pace. Even as transistors reach the atomic scale, the amount of computing power ("compute") used in high-end AI research has continued to grow at an exponential pace *faster* than Moore's Law, doubling every 3.4 months. The result has been a 300,000-fold increase in compute for major AI research projects from 2012 to 2018.[19]

The pace of change in information technology vastly outstrips the pace of change in other technology areas. The DoD fights hard for incremental gains of 10, 20, or 30 percent in many technologies. A doubling of physical performance (range, speed, payload, endurance) for most DoD systems would be remarkable. Yet in information attributes, both military and non-military systems are advancing by orders of magnitude.

The Joint Strike Fighter is a great example. In terms of a fighter's physical characteristics, it is not particularly remarkable. That isn't where its advantages lie. Digitally, though, it is far and away the most advanced military aircraft ever built, and those digital attributes in sensor fusion, data processing, electronic warfare, information management, etc. give it tremendous advantages.

Exponential Growth in Computing Power for Major AI Research Projects



The amount of computing power ("compute") used in major AI research projects has increased 300,000-fold from 2012 to 2018 (doubling every 3.4 months). Exponential growth in information technology (data, networks, compute) contrasts with incremental growth in physical attributes of systems (speed, range, payload, endurance).[20]

The most dramatic changes in warfare in the coming decades will come from huge leaps ahead in the information-centric capabilities of military systems—their ability to sense the environment, process and transmit information, and make decisions. Physically, tomorrow's military hardware may be little different from today. Helicopters, planes, tanks, submarines, and missiles may be marginally better, but not by orders of magnitude. They certainly won't be 300,000 times faster, longer-range, or more maneuverable than today's systems. But they could very well be orders of magnitude smarter. If the U.S. military is to remain competitive in future conflicts, it must prioritize harnessing these exponential trends.

Priority Technologies for Investment

The Department of Defense currently lacks a systematic approach for determining which technologies most matter for achieving future military dominance. Too often, investments appear to be driven by the whims of department senior leaders. This is an unsatisfactory approach. At best, the department is whipsawed from one priority to the next, without the sustained investments needed to mature any one given area. (See Appendix for an example of recent shifting technology priorities by senior defense leaders.) At worst, the DoD is under-prioritizing critical areas due to a lack of a systematic approach for determining how to prioritize investments.

Given the challenge the DoD faces—adapting to exogenous trends in a globalized R&D landscape outside of its control, dominated by exponential growth in information technology—the DoD should adopt a three-tiered strategy for prioritizing technology investments.

Three-Tiered Investment Strategy

01 PRIORITIZE	Prioritize rapidly spinning in digital technologies riding exponential curves.
02 INVEST	Invest in key military-specific tech when there is clear operational value.
03 HEDGE	Hedge against breakthroughs in paradigm-shifting "wild cards."

1. DIGITAL TECHNOLOGIES RIDING EXPONENTIAL CURVES

The highest priority technology area for the DoD should be digital technologies that are riding exponential curves. These technologies are maturing rapidly no matter what the DoD does. There is twice as much money spent annually on information technology as all military spending from every country combined.[21] Information technology is advancing rapidly, and if the DoD does not harness this technology, others will. It is ripe for the taking. The DoD should adopt a technology strategy that prioritizes taking advantage of the most dramatic technological transformation currently under way: the information revolution. If the DoD misses out on this trend, nothing else will matter. The future military will be as useless as cavalry charging tanks. The DoD's number one technology priority should be to rapidly spin-in and militarize digital advancements developing outside of the traditional defense sector and apply them to operationally relevant military problems. Key areas include cyber, electronic warfare, sensors, data, networks, cloud computing, AI, autonomy, robotics, genomics, and synthetic biology. (With the digitization of the human genome, biology is now riding the same exponential curves as other digital systems.) These technologies have the potential to radically transform military command-and-control, speed of decision-making, and the pace of operations. Harnessing these technologies for their full military value is likely to require a dramatic reshaping of warfighting tactics, doctrine, organization, and concepts of operation over time as these technologies are adopted into the force.

2. KEY MILITARY-SPECIFIC TECHNOLOGIES

There inevitably will be some important military technologies that do not have commercial uses. The DoD will have to invest in and mature these technologies itself. Examples include high-energy lasers, hypersonic missiles, stealth (e.g., optical or thermal cloaking), and armor. The DoD should invest in these areas when there is a clear military operational value. However, DoD leaders also should be mindful of the fact that none of these technology areas are likely to see the dramatic, orders-of-magnitude growth rates seen in digital systems. Progress in many of these areas is relatively slow compared with the current growth trajectories in information technology. Technology areas such as materials, optics, energy, and power exhibit more normal technological growth rates. A 10, 20, or 30 percent improvement might be significant. A two-fold or four-fold improvement would be amazing. A 1,000-fold or 10,000-fold improvement is highly unlikely. That is not to suggest that the DoD should not invest in these areas. It should. Indeed, the DoD will need to invest in these capabilities precisely because the commercial sector is not. But the DoD should be realistic about what to expect in terms of payout in these areas. The gains from these systems are likely to be valuable, but not as transformative to military operations as the changes brought about from digital systems.

3. PARADIGM-SHIFTING “WILD CARDS”

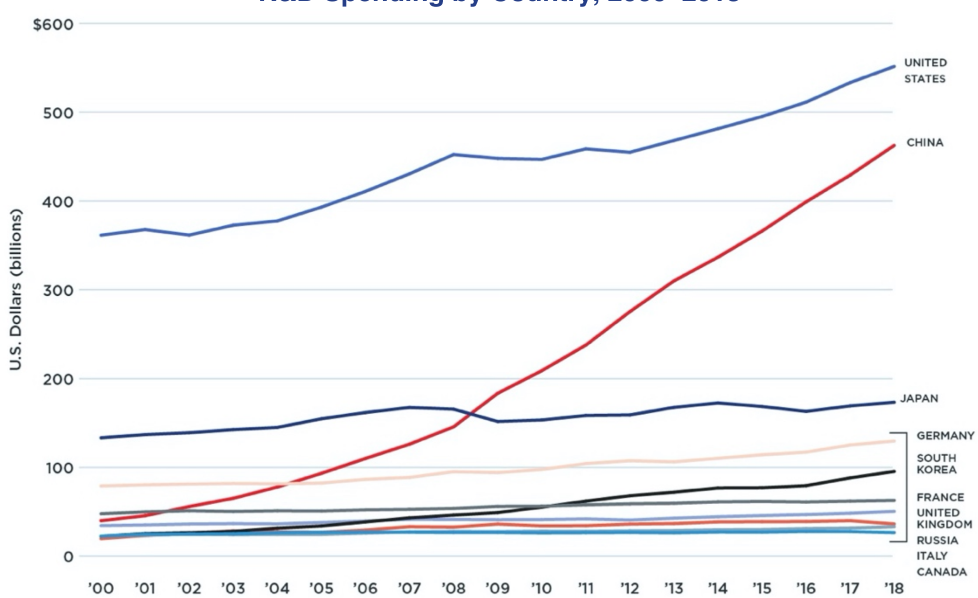
At the same time that the DoD pursues the first two investment areas, it also should retain some investments as a hedge against breakthroughs in paradigm-shifting “wild cards.” These are technology areas that appear to have a low likelihood of reaching operationally relevant maturity in the near term, based on current trends, but would have revolutionary effects if achieved. Examples include quantum technologies (quantum computing, communications, and sensing), brain-computer interfaces, artificial general intelligence, and nanotechnology. The DoD should maintain active research in these and other areas to keep pace with competitors and have early warning if dramatic improvements appear more likely. However, based on current trends, none of these areas appear likely to be sufficiently mature to have a dramatic effect on military operations in the near term. A hedging strategy in these areas would give the DoD the optionality to increase its investments if that appeared to change in the future.

This investment strategy would put the bulk of DoD resources behind harnessing digital technologies that are likely to be the most transformative for future conflicts, while retaining investments in other key areas and hedging against surprise.

The United States Needs a National Technology Strategy

Investing in the right military technologies is not enough. The United States must retain a strong technological base as a nation. Technology is an enduring source of economic competitiveness and, by extension, national economic, political, and military power.

R&D Spending by Country, 2000–2018



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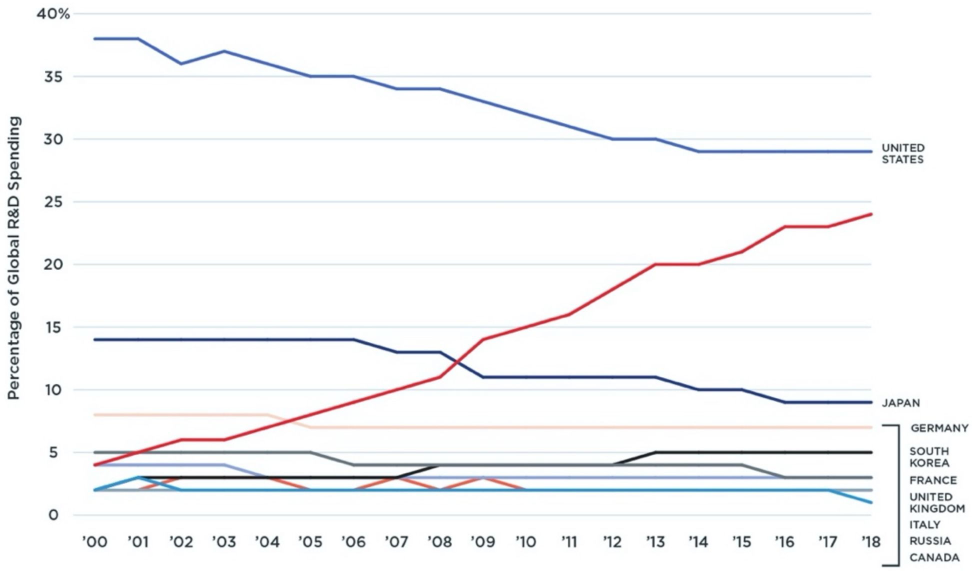
Percentage of Global R&D by Country, 2000–2018



China is poised to overtake the United States in national R&D expenditures. China is already a major player in key areas: AI, genomics, and quantum technologies. The United States needs a national technology strategy that leverages the government, private sector, and allies to compete with China.

Note: Country R&D spending is reported by the OECD in constant U.S. dollars with a base year of 2010, adjusted for purchasing power parity.[22]

China is poised to overtake the United States in R&D expenditures in the next few years. Between 1998 and 2018, China's national R&D expenditures grew an average of 15 percent annually. As a result of its breakneck pace in R&D spending, China has closed the gap with the United States. U.S. R&D spending was nearly 13 times that of China's in 1998, but has been growing at a much slower rate.[23] At its current pace, China will surpass the United States in R&D spending by the early to mid-2020s (in purchasing power parity-adjusted dollars).[24] China is already a major player in a number of key technology areas: quantum technology, genomics, and AI. According to a recent report by the Allen Institute for Artificial Intelligence, China overtook the United States in the most-cited 50 percent of AI research papers in 2019 and will surpass the United States in the most-cited 1 percent of AI research papers by 2025.[25]
The United States needs a national technology strategy to remain a global tech leader. This strategy should harness the combined efforts of the federal government and the U.S. private sector to maintain U.S. leadership in key areas. Key priorities include: increasing federal R&D spending; growing human capital through science, technology, engineering, and mathematics (STEM) education and high-skilled immigration; providing public goods that aid R&D, such as data, computing resources, and standard-setting; and ensuring a policy and regulatory ecosystem that incentivizes innovation. The United States also must work with partner and allied nations to ensure that the global technology ecosystem that develops is one that remains competitive, open, and secure. The competition over 5G wireless technology is just the tip of the iceberg. A global tech ecosystem dominated by China would be harmful to American interests and undermine American national security.

On the current trajectory, China will overtake the United States and will set the "rules of the road" for the future global tech ecosystem. China not only is on track to overtake the U.S. in spending, China also has a more cohesive approach internationally to issues like standard-setting that helps China shape the emerging tech ecosystem in a way that is beneficial to its interests. The U.S. approach is often disjointed and ineffective.

The United States needs a major national effort, akin to the space race, to reverse the current trajectory and reinvigorate its science and technology base. A U.S. national technology strategy should not seek to replicate China's approach of top-down, government-directed investment and picking "national champions." Instead, U.S. policymakers should look to America's own history in the 1960s and '70s as a model for how to reclaim America's position as a global technology leader. The United States has tremendous strengths in this competition, including a vibrant innovation ecosystem, the best universities in the world, and an immigration system that draws top-tier talent from around the globe. Concerted federal government action can help stoke the fires of American innovation, securing another generation of American technological leadership.

Appendix

SHIFTING DEFENSE TECHNOLOGY PRIORITIES

Over the past few years, U.S. defense leaders have publicly communicated an ever-shifting set of technology priorities.

In November 2014, Secretary of Defense Chuck Hagel announced the Defense Innovation Initiative and development of a third "offset" strategy. He unveiled an accompanying "Long-Range Research and Development Planning Program that will help identify, develop, and field breakthroughs in the most cutting-edge technologies and systems—especially from the fields of robotics, autonomous systems, miniaturization, big data, and advanced manufacturing, including 3D printing."[26]

In April 2016, Deputy Secretary of Defense Bob Work remarked that "we believe quite strongly that the technological sauce of the Third Offset is going to be advances in Artificial Intelligence (AI) and autonomy."[27]

In April 2018, Under Secretary of Defense for Research and Engineering (USD(R&E)) Michael Griffin wrote a memorandum to the Defense Science Board requesting "a technology strategy for each of the ten [USD(R&E)] priority technology domains: hypersonics; directed energy; command, control, and communications; space offense and defense; cybersecurity; artificial intelligence/machine learning; missile defense; quantum science and computing; microelectronics; and, nuclear modernization."[28]

Afterwards, Griffin removed nuclear modernization as the 10th priority and replaced it with autonomy:[29]

1. Hypersonics
2. Directed energy
3. Command, control, and communications
4. Space offense and defense
5. Cybersecurity
6. Artificial intelligence/machine learning
7. Missile defense
8. Quantum science and computing
9. Microelectronics
10. Autonomy

The official webpage for USD(R&E), CTO.mil, published a different list of modernization priorities:[30]

1. Artificial intelligence/machine learning
2. Biotechnology
3. Autonomy
4. Cyber

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5. Directed energy
6. Fully networked command, control, and communications (FNC3)
7. Microelectronics
8. Quantum
9. Hypersonics
10. Space

Later, 5G joined the CTO.mil list as the 11th priority:[31]

1. Artificial intelligence
2. Biotechnology
3. Autonomy
4. Cyber
5. Directed energy
6. FNC3
7. Microelectronics
8. Quantum science
9. Hypersonics
10. Space
11. 5G

In July 2019, at his confirmation hearing Secretary of Defense Mark Esper stated: "Different people put different things at number one; [for] me, it is artificial intelligence."[32]

In November 2019, Secretary of Defense Mark Esper offered his top technology priorities during remarks at a conference: "There are a few key technologies out there. I put AI at number one. You know, two, three, and four look like directed energy, and hypersonics, and a few other things like that."[33]

In December 2019, Griffin penned an op-ed highlighting 13 technology areas. "The National Defense Strategy outlines the investments we must pursue: a revitalized nuclear triad, microelectronics, cybersecurity, biotechnology, 5G, space, hypersonics, artificial intelligence, directed energy, autonomous systems, networked communications, missile defense, and quantum science, among others. Superiority in these technologies, woven into a war-fighting architecture that challenges our adversaries rather than reacting to them, is the key to deterring or winning future conflicts."[34]

In January 2020, the Department of Defense outlined key investments in the FY2021 Defense Wide Review: nuclear modernization, space, missile defense, hypersonic weapons, artificial intelligence, and 5G. The review listed nuclear modernization as "the highest modernization priority."[35]

In April 2020, Director of Defense Research and Engineering for Modernization Mark Lewis commented in an interview, "Right now, my number one technology priority prior to—remember, I said it wasn't hypersonics anymore—my number one technology priority is actually microelectronics."[36]

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In June 2020, Lewis added that 5G was the new second priority. The top three priorities are microelectronics, 5G, and hypersonics.[37]

In August 2020, Acting USD(R&E) Michael Kratsios stated in his first public event: “Our immense resources are largely focused on key modernization priorities that align with our new National Defense Strategy and are critical to ensuring our fighting edge on any future battlefield. Among these are microelectronics, 5G, hypersonics, and AI. … More and more, the impacts of these advanced technologies like 5G, quantum computing, artificial intelligence, and other industries of the future quickly extend across borders.”[38]

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